Habitat International 107 (2021) 102306

Contents lists available at ScienceDirect

Habitat International

journal homepage: http://www.elsevier.com/locate/habitatint

Peripherality^{squared}: Mapping the fractal spatiality of peripheralization in the Danube region of Romania

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A B S T R A C T

Starting from the assumption that the core/periphery relations are fractal assemblages of scale of varying intensity, this paper explores and maps at a finely-grained scale the alignment between the *socioeconomic* and *relational* attributes of place in a context of peripherality^{squared} whereby further peripheralization occurs within a 'periphery'. To illustrate this context we focus on the Danube region of Romania. Building on two relatively disparate dimensions of peripherality and mobilizing a range of micro-scale data, we construct the *socioeconomic* and *relational* indexes, separately and combined, in order to identify the fractal spatiality of the region through micro-scale maps. Examining the spatial (mis)match between varying levels of development and connectivity helps identify territorial assets whose development may enable a more even spatiality that reduces spatial exclusion. Our paper invites scholars to question binary core/periphery or dominant/dominated understandings of peripherality. The fact that our indexes were only slightly correlated raises questions on how peripherality should be interpreted and operationalized; further research on the relationship between its socioeconomic and relational dimensions in other regions of the world would be welcomed.

1. Introduction

The European Union (EU) enlargement prompted renewed inquiry on the core-periphery relations between 'the West' and the newly-admitted Central and Eastern European (CEE) countries (Ballinger, 2017; Schweiger, 2018; Ágh, 2016). Economic divergence, quality of governance, institutional transformation, and political stability were seen as major challenges for European integration.

But, we hold, the core-periphery relations are fractal assemblages of scale of varying intensity. In terms of intensity, zooming in for instance within the EU's periphery of the CEE, and further on to the periphery of Romania and Bulgaria, one can see that post-communist regional policies have produced more not less territorial discrepancies (Benedek, 2015; Lang, 2015; Raagmaa et al., 2019) between some 'successful' cities and vast peripheral regions disengaged from development, such as the Danube region of Romania, which we take as our case study. As a metaphor of intensity, we call this territorial expression 'peripherality^{squared}', i.e. peripherality within peripherality. In terms of spatial expression and employing a second metaphor, we propose that peripherality displays 'fractal' spatiality, i.e. notwithstanding the scale one zooms into - continents, countries, regions, cities and even neighbourhoods - the binary core/periphery unpacks in multiple growth poles-fringes relations, displaying continuous heterogeneity rather than homogeneity across places, which can be identified by finely-grained analyses.

To substantiate these conceptual metaphors, this paper aims to explore and map at the finely grained scale of towns and communes the spatial alignment of the *socioeconomic* and *relational* dimensions of peripherality within the Romanian Danube region, whose GDP (nominal)/capita of $7110 (2017) matches countries such as Gabon ($7230) and the Dominican Republic ($7609) rather than the $10808 of Romania as a whole (World Bank, 2017).

Our inquiry is important for three major reasons. First, our study is timely as downward spirals of development are progressing towards the 'desertification' of large territories at the EU's eastern border (Raagmaa, 2015, pp. 287–308), with particular concerns for the region being expressed in the EU Strategy of providing a 'sustainable framework for policy integration and coherent development' (European Commission, 2019). Second and in order to validate our proposed conceptual metaphors, we advance an innovating methodological approach by drawing on two relatively disparate dimensions of peripherality, whose alignment is visualised by means of micro-scale mapping. Third and finally, by substantiating the fractal spatiality of peripherality, our study has wider theoretical currency as it invites scholars to question binary core-periphery understandings within other economic geographies; our study invites scholars to a renewed debate on how peripherality should be best interpreted and operationalized.

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https://doi.org/10.1016/j.habitatint.2020.102306
Received 8 September 2020; Received in revised form 19 October 2020; Accepted 2 December 2020
Available online 13 December 2020

Current debates in economic geography, regional studies and planning (Kühn, 2015; Raagmaa et al., 2019) have engaged with concepts of peripheralization and marginalization. Regional peripheralization is commonly defined as the formation of peripheries in terms of connectivity, economic weakness and political idleness, reflecting a spatially-organized inequality of power relations (Blowers & Leroy, 1994; Fischer-Tahir & Naumann, 2013; Lang, 2015), which is, ultimately, a specific form of uneven development. Accelerated urbanization, especially in the developing world has challenged the role of planning to shape growth. It has led to changes of the spatial patterns of urban and rural areas (Yang et al., 2020), the transformation of the peripheral areas of metropolies (Dadashpoor & Ahani, 2019) and the emergence of new urban habitats (Noronha, Vaz, 2015) that called for complex and varying intersections of planning, drivers of development and processes of change (Todes, 2017). Broadly speaking, two perspectives on peripherality have been advanced in the academic scholarship, which have remained relatively, and particularly empirically, disconnected despite theoretical agreement that both are needed to understand, measure or address peripherality (Binder & Matern, 2020; Lang et al., 2015).

The socioeconomic perspective on peripherality focuses on the dynamics of unequal socioeconomic development between core/non-core regions. Growing concentration of population and economic activity in metropolitan areas, particularly in regional capital cities (Steinführer & Haase, 2007), parallels the development of increasingly disadvantaged rural and deindustrialized regions, stirring displacement to better places (Smith & Rochovská, 2007). Population shrinkage, migration and other processes of social polarization such as age and income determinants (Smętkowski, 2018; Ubarevičienė & van Ham, 2017) produce and reinforce peripheralization (Lulle, 2019), weakening regional performance, income levels and peoples' wellbeing. Less competitive, productive and innovative rural regions are seen as powerless in relation to concentrated, efficient, globalized economies (Lang et al., 2015). However, understanding periphery as a complex adaptive assemblage (Willett, 2019), some scholars challenge this dominant view of peripherality as necessarily lacking innovating power and agentic capabilities, or even the framing of development in binary core/periphery terms (Copus, 2014; Lang, 2015; Raagmaa et al., 2019).

Relational perspectives define peripherality in terms of inaccessibility, being especially concerned with remote and disconnected rural areas where people are (at risk of becoming) 'transport disadvantaged' (Gray et al., 2006; Shürmann & Talaat, 2003). Living in transport-disadvantaged enclaves narrows one's job and life opportunities and brings exclusions from services, thus reinforcing socioeconomic and spatial inequality (Binder & Matern, 2020; Margues et al., 2020). Peripherality here is operationalized in terms of distance to the core, accessibility indexes, population density, and indexes of knowledge-based services. While peripherality is still depicted as powerless, this scholarship (Crone, 2012; Eder, 2019) calls for integrated approaches to economic, social and political inclusion. Supporting a more systematic analysis of the regional characteristics, this perspective challenges the peripheralizing discourses by promoting 'beyond growth' alternative understandings of the nexus between development and growth (Leick & Lang, 2018; Raagmaa et al., 2019).

The remainder of this paper proceeds as follows: section 2 presents a brief history of our study region. Reflecting our fractal view of peripherality and drawing on both perspectives presented above, the methodological section 3 introduces our approach of constructing an aggregate index that combines the socioeconomic *and* relational attributes of place. Findings are discussed and mapped at the micro-scale of towns and communes to identify the fractal spatiality of the region in section 4. Section 5 concludes the paper.

2. The study area

From a geomorphological point of view, the Danube region is a homogeneous space suitably described as a valley bordered by plains (Bălteanu, 2017). Its geography - and our spatial delineation - has been historically recognized as a functional entity, being inscribed in common cultural, political yet not administrative understanding (Geografia Văii Dunării Românești, 1969).

2.1. From buoyance to peripheralization

Free trade and shipping on the Danube and the Black Sea was granted in 1829 to the then Romanian Principalities. The Danube was declared an international navigable waterway in 1856. The European Commission of the Danube, headquartered in the same year in the Romanian port of Galati, endorsed the development of the region as an agricultural outlet. The region enjoyed a demographic and economic boom with flourishing cities connected to the inland by railways and emerging ports from where the locally-produced grains were exported to the European market (de Martonne, 1902).

Under the communist regime (1944–1989) and its industrialization-led development, the region was favoured for the location of metallurgical plants that benefited from transport of raw materials (coal and iron) along the Danube. Investment flew towards old and new shipyards and repair yards, and the construction of ships, engines and tugs. The 1970s national programs of river-front industrialization turned the region into a manufacturing belt. By the late 1980s, one third of the region's towns hosted metallurgical enterprises, showing an overemphasis on heavy industry and dependence on imported raw materials, which seeded the misfortune of post-communist deindustrialization.

There is no doubt that the post-communist political-economic transformations of Eastern Europe progressed under neoliberal policies (Harvey, 2005), an argument which we need not rehearse here. In Romania, as elsewhere, neoliberal (regional) policies have triggered considerable socioeconomic restructuring, changing the spatial structure -a, increasing spatial inequalities, and widening the gaps between 'core' and 'periphery' at the regional scale (Benedek, 2015; Ianoş et al., 2013). In this context, the Danube region has become increasingly marginalized, affected by deindustrialization: e.g., 60.1% of regional manufacturing employment was lost between 1992-2017 (higher than the national average of 56.8%). Lacking large urban agglomerations, the region found increasingly difficult to attract investment while regional redistributive policies have remained insubstantial (Brad, 2018). Deindustrialization has led to des-urbanization and ruralization reducing further opportunities for regional development (Popescu, 2019). Bănică et al. (2013) conceptualized the industrial collapse of one-industry towns as 'de-economization'; the related drastic reduction in services, infrastructure and employment has reinforced the uneven intra-regional development and urban fragmentation, including disconnection between urban and rural.

Socioeconomic disruptions, high unemployment, growing urban poverty and rural subsistence based on self-provision intensified the peripheralization of the region. For instance, the region's contribution to national GDP decreased from 21.9% in the mid-1990s to 17.1% in 2017; underdevelopment has become 'more uniform' (Ianoş et al., 2013); and rural poverty engulfed the south of Romania into a continuous belt with the Danube region at its furthest and poorest end (Sandu, 2011). With few international investments and low potential to trigger endogenously-led development, low levels of innovation and spillover effects, the region remains caught in a slow decline whereby shrinking markets and falling local productivity reduce the opportunities for further development (Ionescu-Heroiu et al., 2013). Such vicious cycles of intensifying peripheralization within the periphery - what we brand peripherality^{squared} - are neither new nor unique to Romania but they rarely make the case of comprehensive, systematic analyses as the one this paper attempts to advance.

2.2. The region's spatial fabric

While the region has historically showed a degree of functional coherence - whether an agricultural outlet or a manufacturing belt along

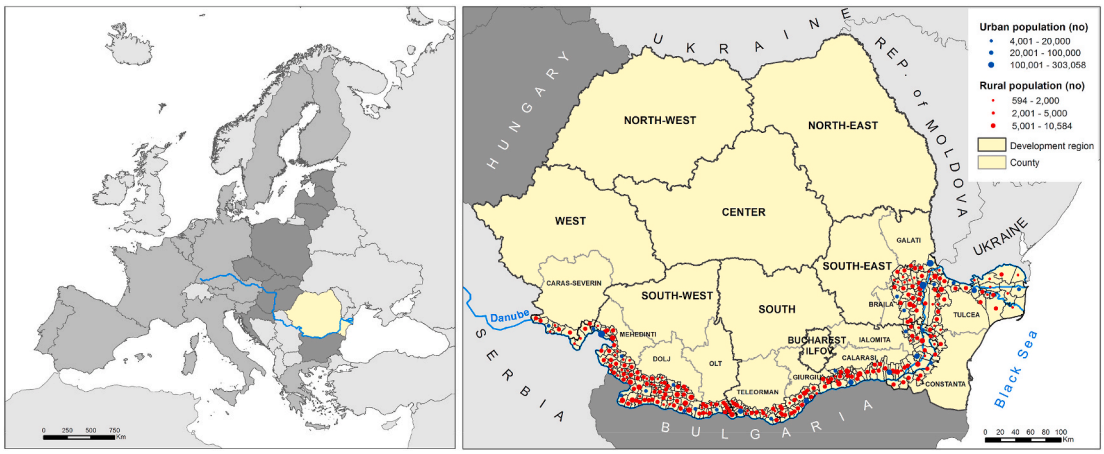

Fig. 1. Study Area in 2017.

a vibrant waterway - this has been recently threatened, including by a territorially fragmented governance structure. Fig. 1 (left) indicates the region's position at the eastern periphery of the EU (part of the CEE's 'periphery') and of Romania (making its southern border).

The study area lays across four development regions and 12 counties (Fig. 1, right), which hampers coordinated action. The settlement fabric consists of five larger cities, 23 small/medium-sized towns and 238 communes. However, recent studies on 'magnet cities' (Cristea et al., 2017; Ionescu-Heroiu et al., 2013) identify the five Danube cities (Brăila, Giurgiu, Tulcea, Călăraşi and Drobeta Turnu Severin) as being less attractive to migration and commuting. Relevant to our analysis of the relational dimension of peripherality are three metropolitan cities located outside the region but extending their catchment areas over it: the Romanian capital of Bucharest and the two county-capitals of Constanţa and Craiova.

The region is strongly affected by population aging and urban shrinkage. Both Romania and our region lost about 14% of the population between 1992 and 2017, which draws attention to the mutually reinforcing processes of shrinkage and peripherality mediated by negative natural growth and (international) outmigration (the latter a strategy to adapt/overcome peripheralization, see Moldovan, 2017). The increasingly dominant rural and aging character of the region (Kulcsár & Brădăţan, 2014) translates into a growing dependence on education and healthcare services provided from outside the region, and to the marginalization of low income social groups (Damian et al., 2019), raising doubt on the internal capacity of the region to attract or retain the population.

3. Data and method

This paper advances an original methodology that captures both the socioeconomic and relational dimensions of peripherality, independently and combined into an aggregate development index. Furthermore, following our ontological view that peripherality displays fractal spatiality and recent calls for more finely-grained analyses that take notice of small settlements (de Souza, 2018), we construct these indexes at the small scale of towns and communes. Our approach remains exploratory and invites scholarly discussion regarding its replicability, revision and relevance to other regions of the world.

We rely on statistical data from the National Institute of Statistics (the free time-series database Tempo online).[1] Additional data on road and rail networks were sourced from the Ministry of Regional Development and Public Administration; and on functional urban areas (FUAs) from the Territorial Observatory (https://ot.mdrap.ro/website/maps/). Following the EU-OECD methodology (Dijkstra et al., 2019), we crosschecked data for validity with World Bank reported values (Cristea et al., 2017; Ionescu-Heroiu et al., 2013). Our aggregated development index is assessed at the local (LAU2) level and includes all the 266 urban and rural areas of the Danube region.

The selection of socioeconomic variables was guided by theoretical relevance and data availability and consistency at the LAU2 level. Following RambØll Group (1996), Mitrică et al. (2017) and Stoica et al. (2020), our socioeconomic development index (SEDI) derives from the aggregation of seven indicators (values for 2017), assessing:

- *Quality of life*: housing (floor area/inhabitant - FLOOR) and public infrastructure (% of sewerage length in the regional network - SEWER);
- *General services provision*: healthcare (no. physicians/1000 inhabitants – DOC)
- *Human capital*: population vitality (the ratio between new-borns and deceased persons*100 – VITAL) and educational level (no. higher education graduates/100000 inhabitants – EDU)
- *Labour market*: employment change rate 1992/2017 (EMPLOY_CH), a temporal variable aimed to capture the processual dimension of peripheralization
- *Social exclusion*: unemployment rate (UR)

Z-values are used (Hull Score values in the spread of 1 and 100) with a mean of 50 and a standard deviation of 14. The SEDI is calculated as the sum of the significance of each variable in the determination process of socioeconomic development:

$$SEDI = 50 + 14*(FLOOR + SEWER + DOC + VITAL + EDU + EMPLOY\_CH - UR)/7$$

Previous studies on peripheral regions in CEE (Smith & Rochovská, 2007; Smętkowski, 2018; Soaita & Dewilde, 2020; Ubarevičienė & van Ham, 2017) use similar variables to address peripherality characteristics, mainly population decline, economic dependence, infrastructural networks and services, and loss of opportunities and life changes. The SEDI index captures different dimensions of peripherality, although additional yet unavailable variables, such as perceptions of local communities and attraction to business, would have been welcomed. Given this limitation and a significant number of secondary indicators, we refrain from interpreting the results along distinct directions. As socioeconomic evidence cannot fully assess peripherality, we next develop the relational index (RI) in order to capture the connectivity of the Danube settlements to job opportunities and services provision in the wider regional context. We construct two indicators:

[1] Matrices POP107D, POP201D, POP206D, FOM104D, SOM101F, SCL109D, SAN104B, LOC103B, GOS110A.

Table 1
The progressive intensity of socioeconomic peripheralization.

	FLOOR	SEWER	DOC	VITAL	EDU	EMPLOY_CH	UR
Danube region	17.25	9.08	1.62	54.38	707.81	−49.20	7.25
Danube counties	18.52	8.58	1.76	61.67	1014.92	−42.64	3.48
All other counties	19.43	12.49	2.81	83.37	2068.90	−24.16	2.35
Romania	19.20	11.42	2.60	78.60	1831.8	−28.20	2.67

Source: authors' calculations.

- *Spatial connectivity*: access to transport network (ACCESS), operationalized as low (no connection); medium (connection to road or rail); high (connection to road and rail) and attributed to each LAU2.
- *Gravitational pull* of the wider region, particularly the capital city of Bucharest and the two national growth poles (Craiova and Constanţa) whose economic influence extend over our region. The regional attraction indicator (REG_ATTRACT) is operationalized by three levels (high, medium, low) based on the time/distance thresholds of 20, 40 and 60 min that define the FUAs where at least 15% of the workforce commute to regional centres. This is based on the EU-OECD methodology[2] updated by Dijkstra et al. (2019) and applied by Ionescu-Heroiu et al. (2013) and Cristea et al. (2017) to the Romanian case.

For harmonization purposes, the ordinal data were converted to numerical data by integer encoding. The RI is expressed as a Hull Score based on standardized values and is calculated as follows:

$$RI = 50 + 14*(ACCESS + REG\_ATTRACT)/2$$

Connection to main communication ways helps identify the 'transport disadvantaged enclaves' (Gray et al., 2006) and the growing 'intra-rural divide' (Rizzo, 2016) as main challenges of the regional peripheralization. Taking account of the specifics of the region and responding to our focus on fractal spatiality, we added the regional attraction variable to assess the gravitational pull exerted by the larger cities located outside the region and the resulting 'spread' versus 'backwash' effects. Our approach of combining the distance and commuting flows to metropolitan cores was tested by previous studies (e.g. Barkley et al., 1996; Chen & Partridge, 2013). Given unavailable data, we are unable to include subjective variables of peripheralization, such as perceptions of regional status and political voice (Blowers & Leroy, 1994) but this arguably increases the consistency of our indexes with all variables being objectively measured.

As there are no theoretical reasons to privilege one perspective over the other and the z scores obtained are both expressed in categorical data, we integrate SEDI and RI into an aggregated peripheral region development index (PRDI) using their weighted averages. The resulting values were grouped in three categories (low, medium, high) delimited by standard deviation. The spatial variation of the indexes was mapped to help visualizing the patterns of socioeconomic and relational peripherality and their interactions.

4. Results and discussion

4.1. The socioeconomic perspective

To qualify the intensity of socioeconomic peripherality in the Danube region, Table 1 compares the average values of our SEDI variables at relevant spatial scales, clearly demonstrating its progressing character. While Romania's peripherality within the EU cannot be measured here but is clearly acknowledged elsewhere (e.g. Grodzicki & Geodecki, 2016), our variables' averages demonstrate the progressive intensity of peripherality from the Danube region (highest) to Danube counties, on to all other Romanian counties, and to Romania as a whole (lowest). Data thus confirm our conceptual metaphor of peripherality^{squared}.

In these average terms and looking at the observed differences between the sample means at various geographical scales, we note the significance of our indicators for quality of life (housing conditions, services provision), human capital and labour-market, all pointing to structural weaknesses of the region. First, poor housing conditions and sanitation facilities are associated with particularly disadvantaged rural places that are dominated by households of the lowest two income quintiles (Soaita, 2019). Second, the demographic potential of the region is challenged by poor healthcare provision, requiring recourse to extra-regional suppliers or accepting deprivation. Social deprivation is reinforced in aging communities (see the low vitality index) and by significant educational disadvantage. Taken together, the low capacity of the region to provide skilled labour and innovation activities is apparent. Third, massively shrinking labour markets pinpoint the local economies' exclusion from dynamic and growing activities. Labour market segmentation, an outcome of deindustrialization, has challenged the socioeconomic sustainability of towns. Given the low levels of education, the 'thin' structure of knowledge suppliers triggers low level of innovation, feeds the declining industries, self-employment in subsistence agriculture and low-skill services.

However, our analysis demonstrates that peripherality is not homogenous but fractal in its spatial distribution (Fig. 2). The variation of SEDI shows significant spatial inequalities. We note a cluster of high SEDI values (less intense peripheralization) in the western and eastern extremities of the region and one of lower values (more intense peripheralization) in the central part. In the latter, the rural/urban divide is 'blurred' with towns and villages displaying similar socioeconomic characteristics. This 'ruralization' of urban economies and lack of centrality hamper the functional integration of the region.

4.2. The relational perspective

Our RI provides further insights into the fractal peripherality of the region. Poor connectivity to road and rail networks is strongly correlated with our SEDI indicators of shrinking labour markets, services and jobs provision. Transport connections are key territorial drivers, stimulating economic growth through opportunities for employment, commuting and interaction. Accessibility and rurality gradients are interdependent and positively correlated: almost one third of the rural areas are not directly connected to the main transport network, forming 'enclaves of low accessibility' challenged by marginalization and sub-optimal development (PROFECY, 2017; URRUC, 2018). Conversely, most urban areas display medium and high accessibility; road and rail connections strengthen their role in facilitating territorial cohesion.

We have already mentioned that three major metropolitan cities - the economic growth poles in the south of Romania, concentrating large amounts of population, jobs and investments - exert gravitational pull over the Danube region. In the middle-west, Craiova expands its economic influence over rural areas and towns such as Bechet, Dăbuleni, Băileşti, and Calafat. In the middle-east, Bucharest engulfs the towns of Giurgiu, Oltenița and Călăraşi while Constanţa's influence extends over Feteşti and Cernavodă (Popescu, 2016). Based on the time/distance gradients, one third of the region's villages are located within (i.e. at

[2] http://ec.europa.eu/regional_policy/sources/docgener/focus/2012_01_city.pdf.

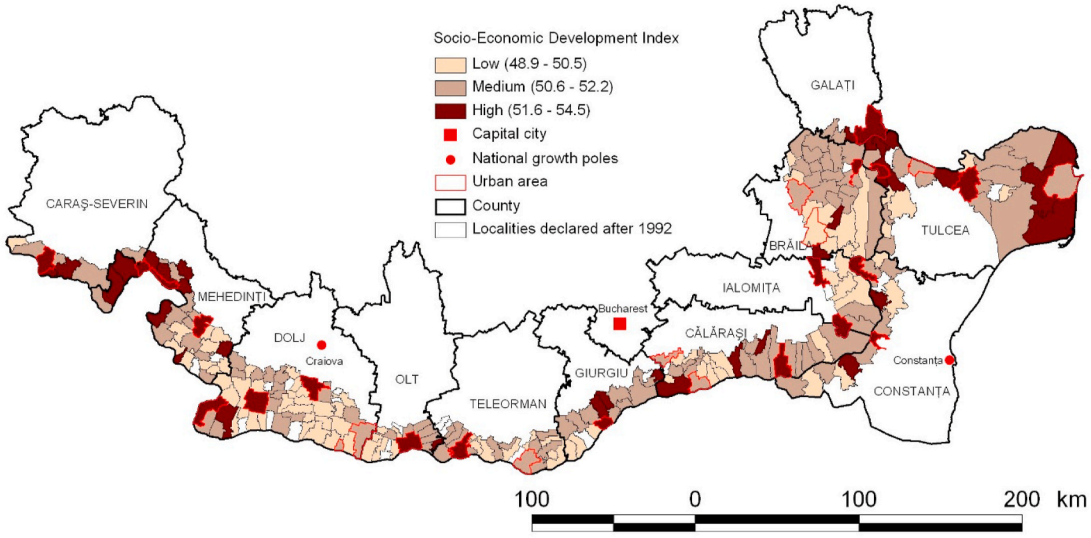

Fig. 2. SEDI's spatial distribution.

20–40 min) or at the fringe (i.e. at 40–60 min) of the FUAs of these three metropolitan centres. In these places, 'spread effects' are expected to bring about positive changes whereas the remaining two thirds of the region's 'disconnected' rural settlements are likely to suffer 'backwash effects'.

Mapping the variation of RI helps identify fractal spatial inequalities across the region's multiple poles and fringes, clearly reflecting the articulation between accessibility and spatial connectivity to the three metropolitan cities (Fig. 3). The rural areas and the many small/medium-sized towns in the central part of the region display mostly high connectivity and proximity to the neighbouring metropolitan areas. Using this relational advantage, the periphery-core functional complementarities may be already activated through interactions/exchanges of employment and activities. Conversely, the western and eastern extremities, which incorporate four larger Danube cities with administrative functions (Brăila, Galaţi, Tulcea and Drobeta Turnu Severin), display mostly medium connectivity and location outside metropolitan areas. These four cities may reap the benefits stemming from agglomeration economies and urban roles, eventually turning into new 'centres' within 'periphery'.

Guided by the Europeanisation process, Romanian urban and regional policy has changed accordingly. Although the EU principles of territorial cooperation and integration have permeated policy circles (Munteanu & Servillo, 2014), the rhetoric remained formalistic, with many overlapping and contradictory strategies and plans. For instance, urban policy aimed at strengthening 20 second-tier cities (of which two in proximity to our case-study region) as alternative growth poles to counterbalance the primacy of Bucharest, allocating them a preferential regional development budget, which contradicted the objective of regional policy of reducing spatial inequalities (Benedek, 2016). Emphasis on large cities to enhance regional performance, especially in lagging regions (Cristea et al., 2017), has actually increased territorial polarization with regional policies failing to sustain a balanced development and functional coherence.

4.3. Perspectives combined: PRDI

The combined socioeconomic and relational perspectives - i.e. SEDI and RI aggregated - provide further insights into the peripheral character of the region. Our SEDI has highlighted the 'blurred' rural/urban dichotomy while RI has pointed to fractal spatialities created by differential accessibility to the main transport networks and proximity to

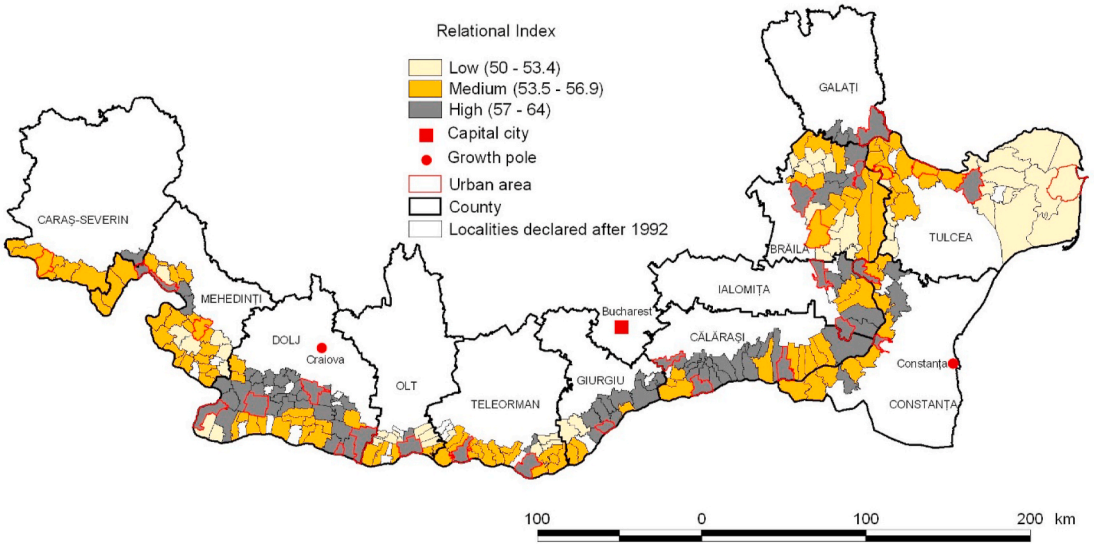

Fig. 3. RI's spatial distribution.

the three growing urban poles outside the region. Our aggregated PRDI displays the same fractal character of peripherality but its particular spatiality differs as the two indexes are only slightly correlated (Pearson coefficient 0.19, $p < 0.1$). This is surprising since connectivity and development are deemed to be bound in a strong causal relation (Crescenzi & Iammarino, 2017) and raises interesting questions for future research on how peripherality should be interpreted and operationalized. In our case, we may tentatively suggest that effects of international migration and remittances - a relational connectivity without proximity - were not captured by our RI but affected SEDI (e.g. remittances are commonly used to improve housing conditions, particularly floor area). Digital connectivity seems a less appropriate explanation in our context of digital exclusion (less coverage; aging population) but may be consequential elsewhere. The explorative, aggregated nature of our indexes as measures of complex development phenomena may also make comparability problematic, influencing the strength of the positive association (for a detailed discussion, see Booysen, 2002); clearly, this is an interesting puzzle to be tested in future research.

Notwithstanding the above puzzle, we can see that proximity to metropolitan catchment areas 'weakens' peripherality by enabling access to mainstream activities and networks, and helps forming small islands of development. Conversely, inaccessibility reduces the internal mobility and the socioeconomic coherence of the region. Much of the Danube region forms the EU river border between Romania and Bulgaria but it lacks cross-country multimodal hubs, with only few bridges and ferryboat connections crossing the river. Thus, the broader peripheral character of the area within the CEE and EU translates into poor cross-border cooperation.

Fig. 4 maps PRDI's spatial variation. The lower values relate to small scale urbanization, high rurality and overlap between socioeconomic underdevelopment and poor connectivity. While most urban areas record medium levels of development, two thirds of the rural areas face low levels of socioeconomic development and spatial connectivity. The higher and lower values are scattered across the region suggesting the reinforcing mechanisms of human capital, economic potential and relational gradients.

However, the fractal spatiality of peripherality materializes in two distinct configurations. One refers to the (mis-)match between connectivity and proximity to metropolitan areas, producing a mosaic-type territorial arrangement of higher/lower values of the PRDI in the central part of the region. The other is manifest at the western and eastern extremities where the values are clearly differentiated along the rural-urban divisions and more homogenous inside each category. Although larger in size, the cities in this case do not spur economic growth over their hinterland.

These findings are consistent with the typical characteristics of peripherality identified by recent research in other CEE contexts. These studies draw attention to growing social polarization (Smętkowski, 2018; Ubarevičienė & van Ham, 2017); outmigration stirred by and reinforcing peripheralization (Lulle, 2019; Raagmaa, 2015); poor transport network (Copus, 2014); and persistence of traditional economic activities and low innovation (Eder, 2019). Studies based on a European scale (PROFECY, 2017; URRUC, 2018), describe 'inner peripheries' (of which the Danube region is one) in very similar terms and add the disconnection from other territories and networks as a particular feature in the same way as our analysis.

5. Conclusions

Taking a non-binary understanding of peripherality expressed by the metaphors of peripherality^{squared} (a metaphor of intensity) and fractal spatiality (a metaphor for continuous spatial heterogeneity), this paper aimed at exploring and mapping at a finely-grained scale the alignment between the socioeconomic and relational attributes of place for the case study of the Romanian Danube region. Through this approach, we aimed to contribute to more comprehensive interpretations of peripheralization. Further deployment of such approaches is critical to build empirical cumulative knowledge that avoids a dominant/dominated narrative. Our metaphors were used as simple ontological descriptors, but their empirical validation has now opened the road to theorising them as fully fledged concepts of regional development, along conversations already opened, e.g. by de Souza (2018) and Warf and Arias (2009).

Without repeating our detailed substantive empirical findings but reflecting at a broader theoretical scale, we found that the fractal spatiality of peripheralization - even in contexts of extreme intensity as in our case study - was revealed by both our indexes and their aggregation. This raises an obvious question of what scale should be privileged in regional research, a debate which we have no space to resume here (see e.g. Brenner, 2001). Suffice to say that, whatever scale may best suit a certain research question, zooming in at a finely-grained scale and out beyond the region (and even the nation) is likely to be rewarding for policy concerns and theoretical reflections.

To our surprise, we noted that our two indexes were only slightly correlated, which we tentatively explained through un-captured effects of international migration, which is a form of relational connectivity-without-proximity hence missed by our RI (but affecting SEDI through remittances). However, this puzzle is clearly worth exploring in future

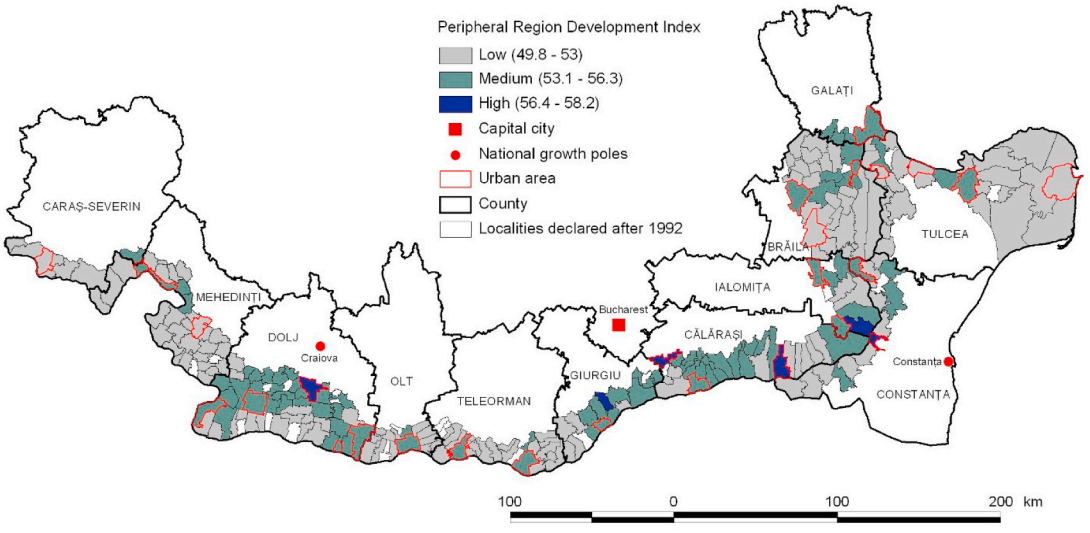

Fig. 4. PRDI's spatial distribution.

research in terms of how we best interpret and operationalize peripherality, and how its socioeconomic and relational dimensions interrelate in other regions of the world, including by taking into consideration other relevant forms of connectivity-without-proximity (e.g. internet access).

Finally, from a policy perspective, our results suggest that connectivity to transport networks remains critical for enhancing the opportunities of a lagging region and its population, including coping with underdevelopment. While policy recommendations for transport improvement have general relevance, our case study displays the specifics of a major waterway, which could be developed to rejuvenate transport both along and across. Building on the Danube as a critical asset for territorial development - as it proved energizing in the pre- and the communist past - requires nonetheless international cooperation between the neighbouring Romania and Bulgaria as well as the EU countries upstream.

Declaration of competing interest

The authors declare that they have no conflict of interest.

Acknowledgements

Our thanks go to the Editor and the two anonymous peer reviewers who found value in our paper and offered welcomed comments. Adriana M Soaita gratefully acknowledges the support of the UK Collaborative Centre for Housing Evidence (CaCHE) funded by the Economic and Social Research Council, Arts and Humanities Research Council and the Joseph Rowntree Foundation (grant number: ES/P008852/1). Claudia Popescu and Mihaela Persu acknowledge the great support provided by the Institute of Geography Romanian Academy: research project 'Geographical Study of the Romanian Danube Valley'. The authors enjoyed working as a team, each contributing equally to the paper. For access to data and protocols please contact the first author.

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